

Cermetek
Microelectronics Inc.

CH1786 Family - 2400bps Modem Ultra Small Module

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114

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INTRODUCTION

The CH1786 is the smallest, full function 2400bps modem that is FCC Part 68 approved. It offers a fast and easy way to integrate a modem into an OEM product while utilizing a minimum amount of PCB space (1" x 1.25" x 0.52"). The CH1786 has two interfaces, a CCITT V.24 serial interface that can be routed directly to a UART, and a Tip and Ring signal which goes directly to an RJ11 jack for the telephone line connection. This unit can be controlled with industry standard AT commands and is hence compatible with available industry communication software.

The CH1786 supports asynchronous operations at 2400bps, 1200bps and 300bps to Bell and CCITT standards. The resident telephone line interface, or Data Access Arrangement (DAA), while being FCC approved, is also Canadian DOC approvable and can be approved in other countries that require 1000 VAC isolation.

The CH1786 operates off a single 5 volt supply. The low power operation and automatic standby mode make the unit ideal for portable equipment. In addition, its small physical size allows flexibility of equipment design.

GENERAL DESCRIPTION

Figure 1 is a functional block drawing of the CH1786. The CH1786 is a highly integrated, full function modem, comprised of a modulator/demodulator, controller, and an FCC Part 68 approved telephone interface, also called a Data Access Arrangement (DAA).

Modulation/Demodulation and Control

This Functional Block is comprised of a monolithic mode integrated circuit, with built-in facilities to accommodate integrated "AT" command control and resident interfaces for general communication and routing to the DAA.

DAA

The CH1786 is designed to meet North American telephone standards as set by FCC Part 68 and DOC. The telephone line interface is designed to meet 1000 VAC and 1500 volt peak surge isolation, among other parameters. As such it will meet U.S. and Canadian requirements and other international requirements that specify that level of isolation. Cermetek manufactures other modules that meet more stringent international requirements. The CH1786 comes with FCC Part 68 approval, a label is provided with the registration number and ringer equivalent. This label should be prominently displayed. As with most countries, except the U.S., Canada requires submission of the product containing the CH1786 for DOC approval. This can be done by submitting the design to a test house or consultant. Call Cermetek for assistance.

FEATURES

- Supports Standards CCITT V.22bis, V.22, Bell 212, and Bell 103
- FCC Part 68 approved and DOC approvable
- AT Command structure - with extensions
- 1000 VAC isolation barrier
- Single 5 volt operation
- Low power operation with automatic reduced power standby mode
- Automatic adaptive and fixed compromise equalization
- Test modes and diagnostics
- Size: 1.0" x 1.25" x 0.53"
- NVRAM allows storage of custom configurations and telephone numbers
- CH1786 Family includes:
 - CH1786 2400bps Modem, Non-volatile RAM, Operating Temperature: -20 to +70°C
 - CH1786ET 2400bps Modem, Non-volatile RAM, Operating Temperature: -40 to +85°C
 - CH1786LC Low cost 2400bps Modem, No Non-volatile RAM, Operating Temperature: 0 to +55°C
 - CH1786FX Same as CH1786, with Send and Receive Fax

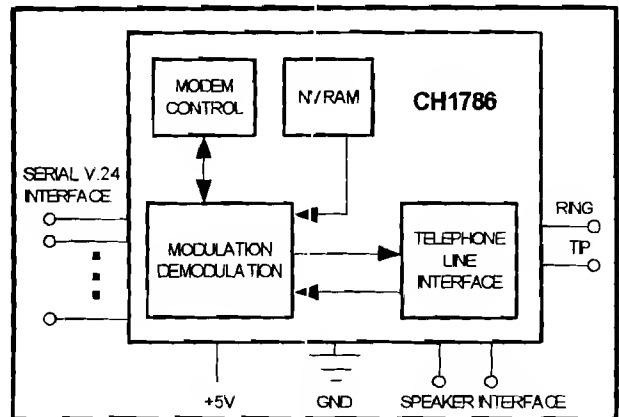


FIG. 1

Supported Features

"AT" Command Set

A 40 character command line is supported. The command line starts with AT and may contain standard or enhanced command. The commands are compatible with EIA document TR302.2/88-08006.

Serial Host Interface

The serial interface is V.24 (EIA-232-D) compatible interface. See pin description.

Speaker Interface

The SPK output reflects the receiver analog input and provides a signal that can be used to monitor call progress. The SPK signal can drive a 300Ω load directly. The SPK signal is usually input to an audio power amplifier and the amplifier drives a speaker coil. Figure 5 shows how to drive an 8Ω speaker.

The speaker can be turned on and off with the ATMn command. The speaker volume can be adjusted by the ATLn command where n is 0, 1, 2, or 3.

Phone Control

The CH1786 contains a pin called Voice/Data ($\overline{V/D}$). This pin toggles high when the modem goes off hook. This pin can be used to activate a relay which can switch a telephone on or off the Tip and Ring Telco lines. This allows the telephone to be disconnected when a data call is in progress, preventing the data from being disturbed by an inadvertent telephone pick-up. See Figure 2.

Sleep Mode

To minimize the modem power consumption the CH1786 includes a power down feature called the Sleep Mode. The CH1786 will automatically enter the Sleep Mode after 0 to 255 seconds of inactivity. The time of inactivity is selected by the ATS24 command and 5 seconds is the default time. The modem returns to normal operation when a ring signal is received or upon a normal input signal on TXD. ATS24 = 255 disables the Sleep Mode.

A \overline{SLEEP} output signal is available to control power to external devices. In Figure 5, a FET controlled by the \overline{SLEEP} signal turns off the external speaker amplifier when the modem enters the Sleep Mode.

If an application calls for zero power during standby periods, a special feature can be added such that when an incoming call is required to wake up the CH1786, the power is switched off and reapplied when RI is active. The CH1786 can be special ordered to support this feature by adding a "P" suffix to the part number e.g. CH1786P, CH1786LCP. The normal operating power will go up by 10% maximum. While in the sleep mode, power will increase to 20 mA. Minimum order for this special part is 100 pieces per release.

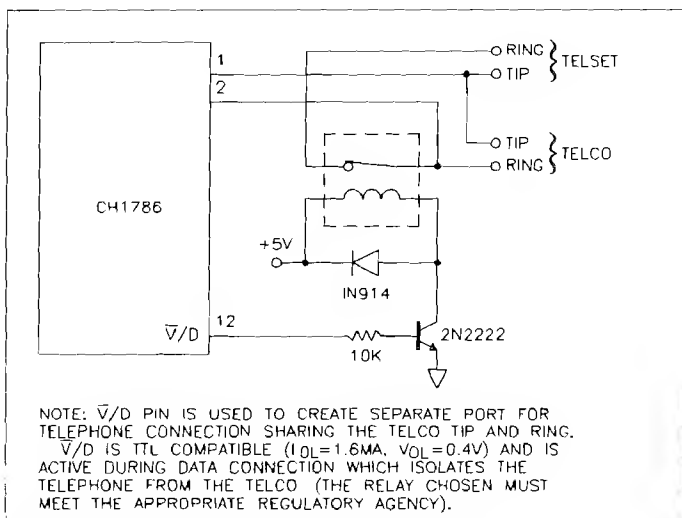


Figure 2 Voice/Data Port Control.

GUARD TONE

A guard tone of 550 Hz or 1800Hz can be generated at 6 dB or 9 dB below the transmit level, respectively.

ANSWER TONE

A CCITT (2100 Hz) or Bell (2225 Hz) answer tone is generated depending on the selected configuration.

Data Encoding

The data encoding conforms to CCITT Recommendations V22 bis or V.22, or to Bell 212A, or 103, depending on the selected configuration.

Line Equalization

Transmitter and receiver digital filters compensate for delay and amplitude distortion during operation on nominal phone lines. In addition, automatic adaptive equalization in the receiver minimizes the effects of intersymbol interference.

Transmission Speed

The transmission rate of the host computer must be 300, 1200, or 2400 bps. The modem will connect at the selected speed or will fallback to the speed set by the remote modem with the serial interface, the DTE transmission speed is speed sensed. The DTE determines the originate speed.

When the modem answers a call, it determines the transmission speed from the carrier signal of the originating modem. The answering modem matches the originate speed. The answering DTE must match this speed.

Speed and Parity Selection

Before a call, the modem adjusts to the host speed (2400, 1200, or 300 bps) and parity (odd, even, mark, space, or none) via host-initiated training sequence. This also selects the speed of the data for originate calls. The modem automatically adapts to the caller's speed on answer calls.

The modem matches the host's parity when it returns status messages to the host. During a data connection, however, the modem passes parity through without interpretation or alteration.

NVRAM

NVRAM can save up to two user-customized mode configurations. The AT&Wn command will store the active mode configuration in one of two NVRAM locations as selected by an n of 0 or 1. The AT^&Yn command selects one of the stored mode configurations to be automatically recalled and activated upon a reset or power up. The ATZn command immediately recalls and activates a stored configuration. See Tables 2 and 3 for storable S-Registers and Commands.

The NVRAM can save up to four telephone numbers, with up to 36 digits or modifiers in each telephone number. The AT&Zn command will store s, the telephone number dial string. The ATSn command will cause the modem to dial one of the four stored telephone numbers. The NVRAM storage location for the four telephone numbers is selected by an n of 0, 1, 2, or 3.

The NVRAM is not available on the CH1786LC.

Power Supply

The modem module is a complex sub-system that may be treated as any other component. Special attention should be paid to the power supply connections. The modem decodes analog signals from the telephone line that are in the millivolt range and even though the modem is designed to withstand significant inductive power supply noise, there is a limit. Steps must be taken to guarantee that power supply noise on all supply lines, including ground, does not exceed 50 mV peak to peak. Any frequency between 20 kHz and 150 kHz must be less than 500 microvolt peak. If necessary, use dedicated power and ground planes. Failure to provide such operating conditions could cause the modem to malfunction.

The CH1786 requires a single $+5V \pm 5\%$ supply. It is recommended that by-pass capacitors be placed on the power supply as close to the modems supply input as practical. It is recommended that a 100 μF Electrolytic capacitor in parallel with a 0.01 μF ceramic capacitor be used.

VOICE/TONE INJECTION PORT

The CH1786 provides two pins to allow the user to share the telephone line interface associated with the modem for voice and DTMF applications. Figure 3 of the application diagrams shows the configuration for voice/tone utilization.

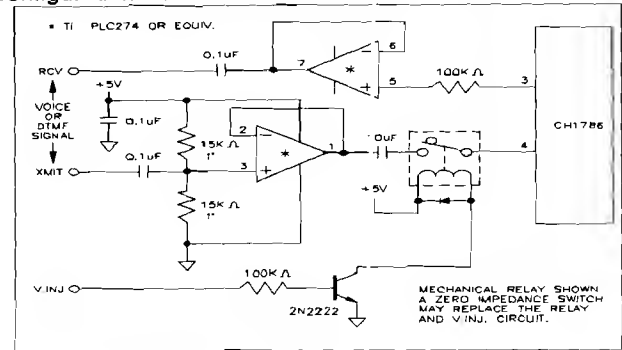


Figure 3. Voice/Tone Injection

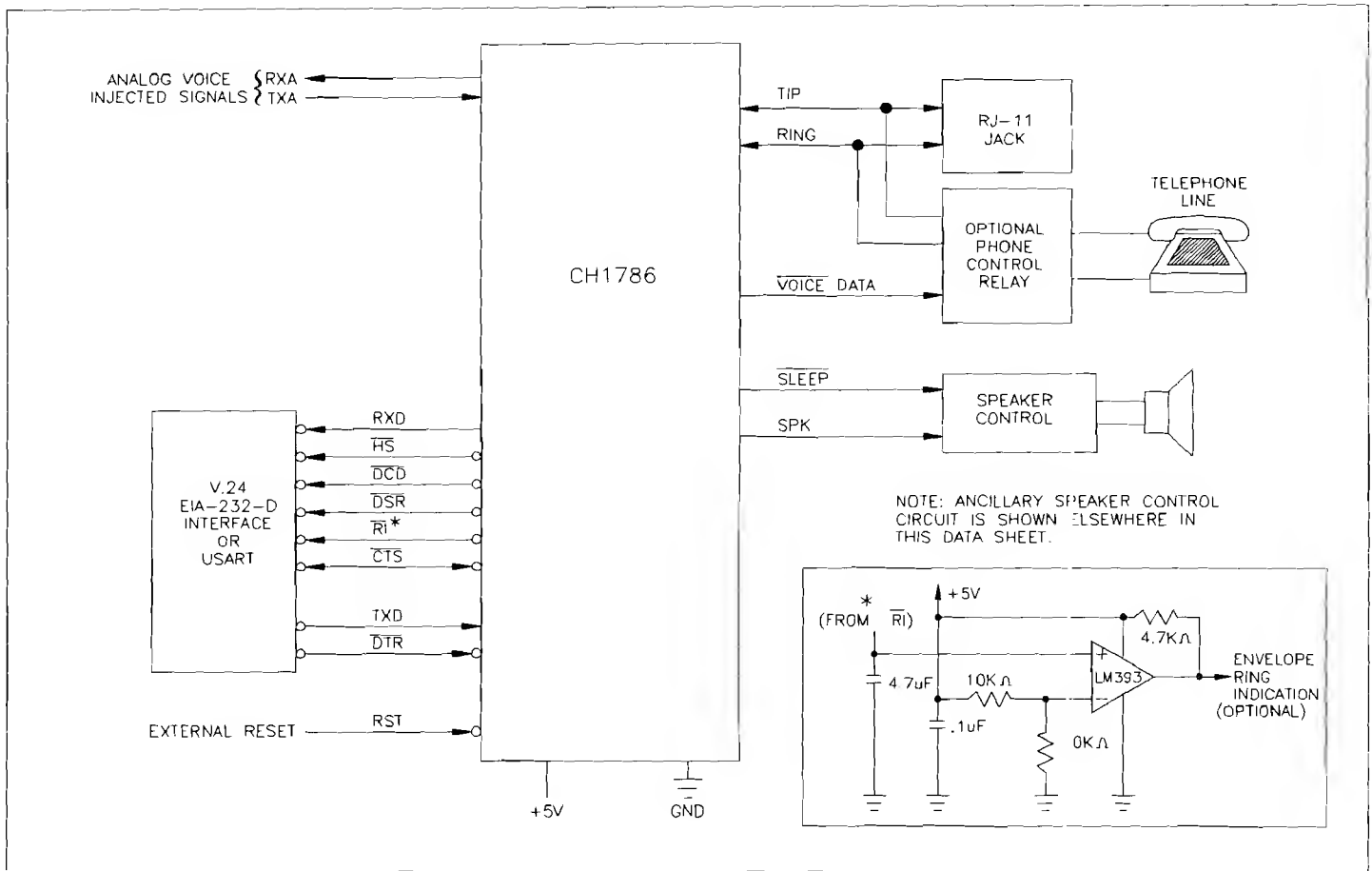


Figure 4 CH1786 Application Diagram

Typically, voice communication would precede data communications; in which case, the following commands should be used to configure the CH1786:

- ```
ATS0=0 [CR]
ATS7=255 [CR]
ATS10=255 [CR]
```
1. To answer a voice call
    - (a) ATH1 [CR]
    - (b) Drive V.INJ. high to activate relay.
    - (c) Begin voice conversation.
  2. To switch to data mode, drive V.INJ. Low, then:
    - (a) At the Originate modem:
 

```
ATX1 [CR]
```
    - (b) At the Answer modem:
 

```
ATA [CR]
```
  3. To disconnect (hang-up) a voice call or a data call:
 

```
ATH [CR]
```
  4. To place a voice call using CH1786's DTMF:
    - (a) ATDT#;C0 [CR]
    - (b) Drive V.INJ. High

**WARNING:** The CH1786 has been FCC Part 68 approved as a data modem. Utilization of the Voice/Tone Port requires further registration. FCC will require that the system, including the CH1786 and the handset or DTMF transceiver, adhere to Part 68 rules.

## MODEM CONTROL

The CH1786 modem may be controlled by sending serial ASCII command sequences. The commands are sent to the modem serially on TXD. After execution of the command, the modem returns a serial status message on RXD, to indicate the completion status of the command.

## Initializing the Modem

Before commands may be sent to the modem, the modem must be initialized. This consists of two events: 1) after power-up a hardware reset pulse must be applied to the modem, and 2) the modem must be trained to the host's speed (2400, 1200, 300 bps) and parity (odd, even, mark, space or none).

## Power-up Reset

After applying power to the modem, an internally generated reset pulse is created. The user can also reset the modem externally by applying the high-going reset pulse to RST for at least 10ms after the +5V power supply has stabilized. Delay sending commands to CH1786 for 100-200ms.

## Training the Modem

The modem must be trained to match the host's speed and parity so that it is able to recognize serial asynchronous commands sent to it by the host UART. The host must retrain the modem each time a reset signal is applied on RST or after a RESET serial command. The modem is trained by sending it the following three character sequence. (Note: There should be a 50-100 ms intercharacter delay between all command characters. Not required for data.)

**AT[CR]**

where: A and T must be upper case or lower case

[CR] represents carriage return

The modem will respond with one of the following status messages, depending on whether it is optioned for abbreviated or English status messages.

[R] (Abbreviated form)  
[CR][LF][OK][CR][LF] (English form)

where: [CR] represents carriage return (ASCII 13)

[LF] represents line feed (ASCII 10)

The modem may be retrained any time while it is idle.

Another attention sequence "A" is much like the "AT" sequence except it repeats the previously entered command specified with a

"AT" prefix. When given, it must also be in upper case ASCII. No carriage return is needed.

## The Command Format

Typical commands consist of three elements, the attention sequence, the commands themselves and a terminating carriage return.

**AT[commands][CR]**

where: [CR] represents carriage return (ASCII 13)

When entering commands to the modem, the backspace character control-H (ASCII 8)-can be used to edit mistakes. "AT" and "A" may not be edited however. Multiple commands may be placed in the command line. A command line may be as long as 40 characters, excluding AT. The command below instructs the modem to configure itself to not echo characters in the command mode (E) and then go to answer mode.

**ATE0A[CR]**

## AT Command Data Rate

With the serial interface, the rate is speed sensed for parity and format.

## AT Command Set

The commands are divided into three types; basic commands, modifiers and ampersand commands as listed in Table 2.

## The Status Messages

The modem responds with a status message after each command is executed. This status message may either be a single digit followed by a carriage return or it may be a carriage return and line feed with a message in English followed by a carriage return and line feed.

The basic status code subsets are enabled with the Xn command. Where n=0,1,2,3,4 the status codes can be in message format or result codes selected for the five Xn commands.

X0 - Result Codes 0, 1, 2, 3, 4

X1 - Result Codes 0, 1, 2, 3, 4, 5, 10

X2 - Result Codes 0, 1, 2, 3, 4, 5, 6, 10

X3 - Result Codes 0, 1, 2, 3, 4, 5, 7, 10

X4 - Result Codes 0, 1, 2, 3, 4, 5, 6, 7, 10 (factory default)

### Result Codes or Status Messages

|                    | Meaning                                   |
|--------------------|-------------------------------------------|
| 0 or OK            | Command executed                          |
| 1 or Connect       | Carrier detected at 300 bps               |
| 2 or Ring          | Ring detected                             |
| 3 or No Carrier    | Did not detect carrier                    |
| 4 or Error         | Entry error                               |
| 5 or Connect 1200  | Carrier detected at 1200 bps              |
| 6 or No Dial Tone  | Off-hook, but no response after 5 seconds |
| 7 or busy          | Busy signal detected                      |
| 10 or Connect 2400 | Carrier detected at 2400 bps              |

**Table 1. CH1786 Pin Descriptions**

| PIN | NAME                      | I/O | FUNCTION                                                                                                                                                                                                                                 |
|-----|---------------------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | RING                      | I/O | Directly connects to the telephone line's Ring lead through a user supplied RJ-11C jack.                                                                                                                                                 |
| 2   | TIP                       | I/O | Directly connects to the telephone line's Tip lead through a user supplied RJ-11C jack.                                                                                                                                                  |
| 3   | RXA                       | O   | <b>ANALOG VOICE INJECTED.</b> Receive signal. Let float if not used.                                                                                                                                                                     |
| 4   | TXA                       | I   | <b>ANALOG VOICE INJECTED.</b> Transmit signal. Let float if not used.                                                                                                                                                                    |
| 5   | SPK                       | O   | <b>SPEAKER.</b> Audio output for speaker. See speaker control diagram.                                                                                                                                                                   |
| 6   | NC                        | -   | No Connection.                                                                                                                                                                                                                           |
| 7   | NC                        | -   | No Connection.                                                                                                                                                                                                                           |
| 8   | $\overline{\text{SLEEP}}$ | O   | <b>SLEEP</b> output. A LOW indicates modem is in low power idle mode. Used to control power to other devices. See Figure 5.                                                                                                              |
| 9   | NC                        | -   | No Connection.                                                                                                                                                                                                                           |
| 10  | TXD                       | I   | <b>TRANSMIT DATA.</b> Serial transmit data input. Marking, or a binary 1 condition, is transmitted when a HIGH is asserted.                                                                                                              |
| 11  | RXD                       | O   | <b>RECEIVE DATA.</b> Serial receive data output. Received MARKING or a binary 1 condition is indicated by a HIGH.                                                                                                                        |
| 12  | $\overline{\text{V/D}}$   | O   | <b>VOICE/DATA</b> output. Used to control a switch between modem and attached phone. See Figure 2.                                                                                                                                       |
| 13  | $\overline{\text{DTR}}$   | I   | <b>DATA TERMINAL READY</b> input. Active Low. Switching off DTR can either return modem to command state, disconnect phone call, or reset modem.<br>DTR should be set LOW when not used.                                                 |
| 14  | $\overline{\text{DSR}}$   | O   | <b>DATA SET READY</b> output. LOW indicates handshaking with a remote modem is in progress, or the data carrier of a remote modem is detected.                                                                                           |
| 15  | $\overline{\text{RI}}$    | O   | <b>RING INDICATION:</b> A LOW indicates that the local telephone line is ringing. This signal follows the frequency of the ringing signal (normally about 20 or 30 Hz for 2 seconds).                                                    |
| 16  | $\overline{\text{CTS}}$   | O   | <b>CLEAR-TO SEND</b> output. Always LOW. Reserved for flow control with fax option. Only active on CH1786FX.                                                                                                                             |
| 17  | $\overline{\text{DCD}}$   | O   | <b>DATA CARRIER DETECT</b> output. LOW indicates a data carrier from a remote modem is detected.                                                                                                                                         |
| 18  | $\overline{\text{HS}}$    | O   | <b>SPEED INDICATION.</b> High speed select output. A low on this pin indicates the modem is operating at 2400 bps.                                                                                                                       |
| 19  | VCC                       | -   | 5 Volts $\pm$ 5%      Note: Noises should be less than 50MV.                                                                                                                                                                             |
| 20  | GND                       | -   | <b>GROUND.</b>                                                                                                                                                                                                                           |
| 21  | RST <sup>(1)</sup>        | I   | <b>RESET</b> input (active HIGH). This input must be asserted HIGH for at least 10 ms to reset the modem. RESET is then returned LOW for normal operation. If no system reset is available, let this pin float to enable internal reset. |
| 22  | NC                        | -   | No Connection.                                                                                                                                                                                                                           |

Note: (1) If VCC has a slow power up ramp time, the internal reset may be ineffective.

| Table 2. CH1786 Register Summary |                               |
|----------------------------------|-------------------------------|
| Register                         | Function                      |
| S0*                              | Ring to Answer On             |
| S1                               | Ring Count                    |
| 2                                | Escape Code Character         |
| S3                               | Carriage Return Character     |
| S4                               | Line Feed Character           |
| S5                               | Back Space Character          |
| S6                               | Wait For Dial Tone            |
| S7                               | Wait Time for Data Carrier    |
| S8                               | Pause Time for Comma          |
| S9                               | Carrier Detect Response Time  |
| S10                              | Lost Carrier to Hang-up Delay |
| S11                              | DTMF Dialing Speed            |
| S12                              | Escape Code Guard Time        |
| S14*                             | Bit Mapped Options Register   |
| S16                              | Modem Test Options            |
| S18*                             | Test Timer                    |
| S21*                             | Bit Mapped Options Register   |
| S22*                             | Bit Mapped Options Register   |
| S23*                             | Bit Mapped Options Register   |
| S24                              | Sleep Mode Inactivity Time    |
| S25*                             | Delay to DTR                  |
| S27*                             | Bit Mapped Options Register   |
| S28*                             | Bit Mapped Options Register   |

\* = S-Registers stored in NVRAM upon receipt of &W command

| Table 1-3. Fax Command Set Summary |                                          |
|------------------------------------|------------------------------------------|
| Fax Command                        | Function                                 |
| =CLASS=n                           | Select Service Class                     |
| =F<command>?                       | Report Active Configuration              |
| +F<command>=?                      | Report Operating Capabilities            |
| +FAA=n                             | Data/Fax Auto Answer                     |
| +FF                                | Enhanced Flow Control                    |
| +FTS=n                             | Stop Transmission and Wait               |
| +FRS=n                             | Receive Silence                          |
| +FTM=n                             | Transmit Data                            |
| +FRM=n                             | Receive Data                             |
| +FTH=n                             | Transmit Data with HDLC Framing          |
| +FRH=n                             | Receive Data with HDLC Framing           |
| +FRTn                              | Receive Test Data                        |
| +FTTn=m                            | Transmit Test Data                       |
| +Hn                                | Rockwell Protocol Interface (RPI) Enable |

## Modem States

The modem can be in either a command state or a data mode state. When the modem is idle, it is in the command state. When a data call is in progress it is in the data mode state. The modem does not recognize commands when in the data state. To recognize commands, the computer must send an "escape sequence" to the modem that forces it out of the data mode and into the command mode.

The escape sequence consists of a "guard time" (a period where no characters are sent to the modem) followed by 3 escape characters followed by a "guard time" again. At powerup, the guard time is set to 1 second minimum and the escape character is set as "+". These two parameters can be modified via registers S2 and S12.

The modem will stay off-hook with its carrier on after the escape sequence is received. It returns an OK status message when it is ready to accept commands. You may re-enter the data mode by issuing the ONLINE command ATO[enter].

| Table 3. CH1786 "A" Command Set Summary |                                      |
|-----------------------------------------|--------------------------------------|
| Basic Commands                          | Function                             |
| AT                                      | Attention Code                       |
| A                                       | Answer Command                       |
| A/                                      | Repeat Last Command                  |
| *Bn                                     | Communications Standard Option       |
| C                                       | Squelch Transmitter                  |
| D                                       | Dial Command                         |
| *En                                     | Off-line Character Echo Option       |
| Hn                                      | Switch Hook Control Option           |
| *Ln                                     | Speaker Volume Option                |
| *Mn                                     | Speaker Control Option               |
| On                                      | On-line Command                      |
| P                                       | Pulse Dial                           |
| *Qn                                     | Result Code Display Option           |
| Sn                                      | Select an S Register                 |
| Sn=                                     | Write to an S Register               |
| Sn?                                     | Read an S Register                   |
| *Vn                                     | Result Code Form Option              |
| *Xn                                     | Result Code Set/Call Progress Option |
| +++                                     | Escape Code Sequence                 |
| ,                                       | Pause                                |
| ?                                       | Returns Last Addressed S Register    |
| *Yn                                     | Long Space Disconnect Option         |
| Fn                                      | On Line Echo Character Option        |
| Z                                       | Reset                                |

| Dial Modifiers | Function                      |
|----------------|-------------------------------|
| P              | Pulse Dial                    |
| R              | Originate Call in Answer Mode |
| T              | Touch Tone Dial               |
| W              | Wait for Dial Tone            |
| ,              | Return to Idle State          |
| @              | Wait for Quiet Answer Command |
| !              | Flash Hook                    |
| ,              | Pause                         |
| 0-9            | Dial Digits/Characters        |
| A,B,C,D        |                               |

| Amperand Commands | Function                      |
|-------------------|-------------------------------|
| * &Cn             | Data Carrier Detect Option    |
| * &Dn             | Data Terminal Ready Option    |
| &F                | Load Factory Defaults         |
| * &Gn             | Guard Tone Option             |
| * &Pn             | Make to Break Ratio Selection |
| * &Sn             | Data Set Ready Option         |
| &Tn               | Test Command Option           |
| &V                | View Active Configuration     |
| * &Wn             | Store active profile          |
| * &Yn             | Recall active profile         |
| * &Zn             | Store telephone numbers       |

| Percent Commands | Function                        |
|------------------|---------------------------------|
| %Dn              | DTMF Attenuation                |
| %J               | Load Secondary Factory Defaults |

Note: A detailed definition of all commands and registers is available from Cermetek Microelectronics, Inc.

\* = Commands that can be stored in NVRAM.

Not supported by the CH1786LC.

## "AT" COMMAND APPLICATIONS

Pause ",",

When placing a call from an office with a telephone connected to a PBX, it may be necessary to dial an access code (usually the digit 9) to get an outside line. Inserting a comma in the telephone number commands the modem to pause for a specific length of time. The factory default pause time is 2 seconds.

**Example:** Dial 9, pause, dial number.

Enter: AT DT9, 1234567

Multiple commas may be used for a greater delay time.

## Touch Tone And Pulse Dialing "T and P"

The modem can use DTMF (touch-tones) or dial pulses when dialing a telephone number. If the dial command does not specify which type to use, the modem defaults to the type last specified. The power-on default value is P.

**Example:** Pulse dial 9, pause, touch-tone dial number.

Enter: AT DP9, T1234567

## Originate a Call in Answer Mode "R"

The D command forces the modem into originate mode. To call an originate-only modem, dial the number and set the modem to answer mode via the R (reverse originate). Enter the R command at the end of the telephone number.

**Example:** Dial number in answer mode.

Enter: AT D1234567R

## Redial Last Number "A/"

Use A/, the repeat command, to redial the last telephone number dialed when a busy signal is received.

## Return to Command State";"

The modem can be forced to reenter the command state after dialing (without hanging up) by ending the dial command with a semicolon. This is useful when using the modem as an auto dialer.

**Example:** Touch-tone dial 9, pause, dial number, return to command.

Enter: AT DT9, 1234567;

Result: OK

## Automatic Answering

The S0 register controls the number of rings that must occur before the modem answers a call. The register may range in value from 0-255.

|      |                         |
|------|-------------------------|
| S0=0 | DO NOT ANSWER TELEPHONE |
| S0=1 | ANSWER ON RING 1        |
| S0=2 | ANSWER ON RING 2        |
| S0=3 | ANSWER ON RING 3        |

SO=255 ANSWER ON RING 255

When S0 is set to 0, the modem will not auto-answer.

**Example:** Assign the value "6" to S0 to set the modem to answer on the sixth ring.

Enter: AT S0=6

Result: OK

## Dial a Number "D"

The Dial command takes the form Dn, where n is a string of characters. In the simplest form, n will be only the digits of the phone number to be dialed.

**Example:** Dial number.

Enter: AT D1234567

In response to this command, the modem dials the telephone number "123-4567" and then waits for carrier from a distant modem. If no carrier is detected within a given time (the default time is 30 seconds), the modem automatically releases the line and sends a NO CARRIER result code. If carrier is detected, the modem gives a CONNECT result code and goes on-line, permitting communication with the distant modem.

The Dial Command may also be issued without a telephone number. ATD causes the modem to pick up the telephone line without dialing a number.

## Connecting to the Host UART

Since a modem communicates data serially and most host products handle data in a parallel form, a UART is needed to make parallel-to-serial and serial-to-parallel translations.

## The Serial Interface Lines

The module supports a full RS-232C/V.24 serial interface. Signal levels are TTL rather than RS-232C level compatible, which allow you to directly connect the modem to your host's UART without level translating circuitry. A complete description of each signal follows under Pin Description.

Three of these lines must be utilized for proper modem operation: TXD, RXD and DTR. The modem is controlled by sending it serial commands over TXD and can be monitored by serial status messages returned on RXD. DTR must be asserted ON (LOW) for the modem to interpret commands sent to it on TXD and will disconnect a call if DTR is asserted OFF (HIGH) during a call.

All other serial interface lines may be utilized for the convenience of your application but are not required by the modem. Unused outputs (from modem) should be left unconnected. Unused inputs should be tied to the proper logic level.

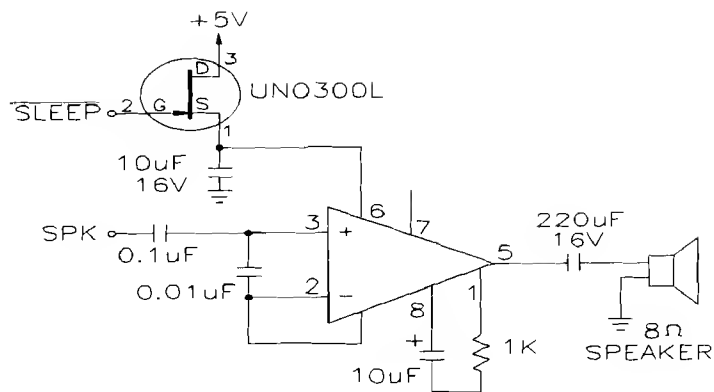
## Fax Modes (CH1786FX only)

The CH1786FX supports Send and Receive Fax in addition to the modem functions as defined by CH1786.

Fax modes and rates are determined by the AT=F commands.

Fax modem processing is explicitly defined in CCITT V.29, CCITT V.27 ter, and CCITT V.21 recommendations. All modulation waveform spectrum and data processing functions conform to the appropriate specifications.

For additional information on CCITT recommendations, contact Omnicon, Tel: 703-281-1135 or see Rockwell's RC224A Fax Designer's Guide, Tel: 714-221-4600.



**Figure 5. Speaker Control Circuit - optional to allow for call progress monitoring.**

## Phone Line Connection Guidelines

1) The mounting of the CH1786 in the final assembly must be made so that it is isolated from exposure to any hazardous voltages within the assembly. Adequate separation and restraint of cables and cords must be provided.

2) The circuitry from the CH1786 to the telephone line interface must be provided in wiring that carries no other circuitry than that specifically allowed in the rules (such as A and A1 leads).

3) Connection to the phone line should be made through an RJ-11 jack.

4) Traces from the modem's RING and TIP pins to the RJ-11 jack must exceed 0.1 inch spacing to one another and 0.2 inch spacing to all other traces. The traces should have a nominal width of 0.021 inches or greater.

5) The RING and TIP traces should be as short as possible and oriented to prevent coupling other high speed or high frequency signals onto the host circuit card.

6) No additional circuitry other than that shown in the following Figure may be connected between the modem module and the RJ-11 jack.

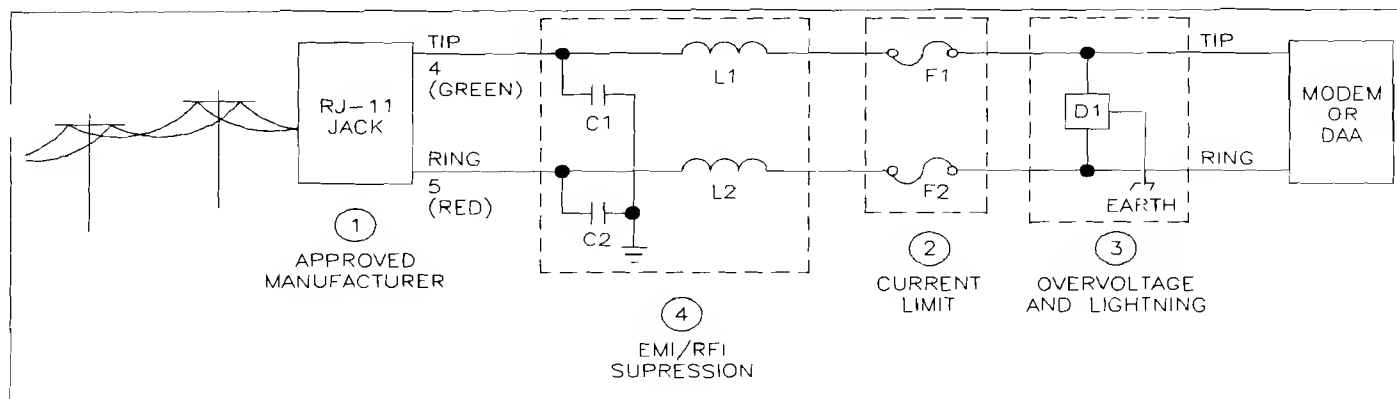
7) The CH1786, the RJ-11 jack and the interfacing circuitry and traces in between, must be mounted on a circuit board with a 94 V-0 flammability rating.

8) The supplied FCC registration label must be applied visibly on the outside of the host product.

9) The host product's User Manual must provide the user with instructions for connection and use as recommended in Section FCC Registration.

## International Approvals

The CH1786 can additionally be approved for some international telephone connections. This must be done, however, after the modem is installed in the host product. The entire host product must then be submitted to the international country's Telephone Network for approval.



1) Manufacturers list - see FCC Public Notice #42269, dated 3/23/94. RJ11 Jacks, must be provided by one of the vendors on this list.

2) Current Line Device: F1 and F2 - 1.25 amp

A. UL 1459 must use a current limit device. A Raychem Poly Fuse TR 600-150 is recommended as this device resets automatically after each power cross. Acceptable devices are fuses from Little Fuse, type 25101.5 or Cooper Ind. Bussman, type MCR 1 1/2.

B. Resistors (10 ohm carbon film or SMD 1/8 w min) can be used for non UL applications.

3) Over Voltage and Lightning Protection

A. The Device is provided with an internal sidactor device that protects from metallic voltage surges.

B. DOC (Canada) May require current limit devices external to the module. Use 10hm resistors (carbon film or SMD parts 1/8 w min) in each lead (Tip and Ring). You may also substitute fuses or the PolyFuse described in Section 2.

C. For lightning prone areas where there are more than 2 storms per year. Provide an earth ground connection and the following part, (this is FCC or DOC acceptable). Teccor Sidactors P3203AB or P3100BA70. These devices give metallic and longitudinal protection for the modem. This must also include the current protection of Section 2.

4) EMI/RFI Suppression

The capacitor/inductor network should be located as close to the RJ11 Jack as possible with excellent ground path to the chassis.

Capacitors C1 and C2 should not exceed .005 mF. They must have a rating of 1.5 KV and typically are on .001 +/- 20%.

Inductors L1 and L2 are Fair-Rite 2643666611 or 2943666661. These are ferrite cylinders and provide attenuation to high frequencies from system level components beyond the modem. These values are to be adjusted per the product design.

**Figure 6 Telephone Line Interface**

## MOUNTING THE MODEM

The modem contains static sensitive devices and should only be handled by personnel and in areas that are properly protected against static discharge.

There are two popular mounting techniques that are recommended for physically connecting the modem to your circuit card; 1) sockets, and 2) direct soldering. Each approach has its own set of benefits and challenges.

If the modem is wave soldered on a circuit card, flux and other corrosive chemicals can be left inside the modem's plastic housing. Care should be taken during the freon rinse cycle to fully wash the chemical residue away. Ideally, the modem should be soldered in by hand after the rest of the card is wave soldered to minimize this problem. Also, soldering can present a sizable challenge if the modem ever needs to be removed from the card.

The socketing approach to mounting eliminates cleaning and desoldering concerns. When socket is used, it must make a solid connection to all modem pins. Failure to do so will cause unreliable modem operation. Also, steps should be taken to assure that the module remains tightly seated in the socket after the host product is shipped.

## FCC REGISTRATION

The CH1786 is registered with the FCC (Federal Communications Commission) under Part 68. To maintain the validity of the registration, you must serve notice to the end user of the product that contains the modem of several restrictions the FCC places on the modem and its use. The following notice is recommended and should be included in the host product's USER MANUAL. Also, the FCC requires that Cermetek make all repairs to the modem. If a repair is necessary after the modem is installed in your product and has been delivered to your customer, the modem must be returned to you where it can be removed from the host product and the returned to Cermetek for repair.

### Changes in Attestation Procedure for Plugs and Jacks

(Name of applicant) attests that the network interface plugs or jacks used on this equipment comply with and will continue to comply with the mechanical requirements specified in Part 68, Sub-part, F specifically the dimensions, tolerances and metallic plating requirements. The compliance of these connectors will be assured by purchase specifications and incoming inspection. Documentation of such specifications and/or inspections will be provided the FCC within 30 days of their request for same.

## FOR YOUR USER'S MANUAL

The Part 68 rules require the following or the equivalent information be provided to the end user of equipment containing a DAA:

**Type of Service:** The (insert your product name) is designed to be used on standard device telephone lines. It connects to the telephone line by means of a standard jack called the USOC RJ-11C (or USOC FJ45S). Connection to telephone company provided coin service (central office implemented systems) is prohibited. Connection to party lines service is subject to state tariffs.

**Telephone Company Procedures:** The goal of the telephone company is to provide you with the best service it can. In order to do this, it may occasionally be necessary for them to make changes in their equipment, operations or procedures. If these changes might affect your service or the operation of your equipment, the telephone company will give you notice, in writing, to allow you to make any changes necessary to maintain uninterrupted service.

In certain circumstances, it may be necessary for the telephone company to request information from you concerning the equipment which you have connected to your telephone line. Upon request the telephone company, provide the FCC registration number and the ringer equivalence number (REN); both of these items are listed on the equipment label. The sum of all of the REN's on your telephone lines should be less than five in order to assure proper service from the telephone company. In some cases, a sum of five may not be useable on a given line.

**If Problems Arise:** If any of your telephone equipment is not operating properly, you should immediately remove it from your telephone line, as it may cause harm to the telephone network. If the telephone company notes a problem, they may temporarily discontinue service. When practical, they will notify you in advance of this disconnection. If advance notice is not feasible, you will be notified as soon as possible. When you are notified, you will be given the opportunity to correct the problem and informed of your right to file a complaint with the FCC. Contact your telephone company if you have any questions about your phone line.

In the event repairs are ever needed on the (insert your product name), they should be performed by (insert your company name) or an authorized representative of (insert your company name). For information contact: (insert your company address).

## DEFAULT STATUS, PERFORMANCE AND SPECS

### Default Configuration Profile

Async mode selected  
 ~400 bps  
 Full 212A operation at 1200 bps  
 Even parity  
 Auto answer enabled (Disabled on CH1786LC)  
 Command echo ON  
 All result codes enabled - extended  
 Wait for dial tone before dialing - 2 seconds  
 Detects busy signal  
 Full word result codes  
 Pulse dial make/break ratio = 39/61  
 DSR enabled  
 Modem enabled DTR (Disabled on CH1786LC)  
 DCD enabled (Disabled on CH1786LC)  
 Speaker enabled but off when receiving carrier

Speaker volume set to medium  
 Local modem will grant RDL request from remote modem  
 Guard tones disabled  
 Minimum DTR pulse width = 0.1 seconds  
 Ring count - 01 (CH1786)  
 Escape code character = 43  
 Carriage return character = 13  
 Line feed character = 10  
 Back space character = 08  
 Duration of wait for dial tone = 02 seconds  
 Duration of wait for carrier after dialing = 30 seconds  
 Duration of dial pulse (comma) = 02 seconds  
 Carrier detect response time = 0.1 seconds  
 Escape code guard time = 1 second  
 Length of use after comma = 2.0 seconds  
 Last carrier to hang up delay = 0.1 seconds  
 DTMF interdigit delay = 0.1 seconds  
 DTMF Attenuation = -4dB  
 Sleep mode inactivity time = 5 seconds  
 Long space disconnect disabled

Table 4. CH1786 System Data Mode Compatibility Specifications

| Parameter                                        | Specification                                                                                                                                     |
|--------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| Asynchronous Speed Range                         | 2400, 1200, 600bps, character asynchronous. 0-300 bps asynchronous                                                                                |
| Asynchronous Format                              | TxD may differ = 1%, -25% from modem output. Offsets will be corrected by adding/deleting stop bits.                                              |
| Telephone Line Interface                         | 8, 9, 10 bits, including start, stop, parity                                                                                                      |
| Modulation                                       | V.22 bis, 16 point QAM at 600 baud. V.22 and 212A, 4 point DPSK at 600 baud. 103 binary phase coherent FSK.                                       |
| Self Test Pattern Generator                      | Alternate 'ones' and 'zeros' and error detector, to be used long with most loopbacks. A number indicating the bit errors detected is sent to DTE. |
| Transmit Carrier Frequencies V.22 bis V.22, 212A | Originate 1200Hz<br>±.01%<br>Answer 2400Hz ±.01%                                                                                                  |
| Bell 103 mode                                    | Originate 'space' 1070Hz ±.01%<br>Originate 'mark' 1270Hz<br>±.01%<br>Answer 'space' 2025Hz<br>±.01%<br>Answer 'mark' 2225Hz<br>±.01%             |

| Parameter                                        | Specification                                                                                                                                                       |
|--------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Receive Carrier Frequencies V.22 bis, V.22, 212A | Originate 2400Hz ±7Hz<br>Answer 1200Hz ±7Hz                                                                                                                         |
| Bell 103                                         | Answer 'space' 2025Hz ±7Hz<br>Answer 'mark' 2225Hz ±7Hz<br>Originate 'space' 1070Hz ±7Hz<br>Originate 'mark' 1270Hz ±7Hz                                            |
| Receiver Sensitivity                             | OFF to ON threshold--43 dBm<br>ON to OFF threshold--48 dBm                                                                                                          |
| Hysteresis                                       | 2 dB minimum                                                                                                                                                        |
| Line Equalization                                | Fixed compromise equalization, transmit. Adaptive equalizer for PSK/QAM, receive                                                                                    |
| Diagnostics Available                            | Local analog loopback.<br>Local digital loopback.<br>Remote digital loopback.<br>Request remote digital loopback.<br>Local interface loopback modem with self test. |
| Call Progress Tones Detected:                    | With speaker or quiet screen messages (no dial tone, busy, ring-back, modem answer tone and voice.)                                                                 |
| Computer Interface:                              | IBM PC/XT/AT bus compatible with an 8250/16450/16550A UART as a serial controller.                                                                                  |

**Table 5.**  
**CH1786 Electrical Specifications**

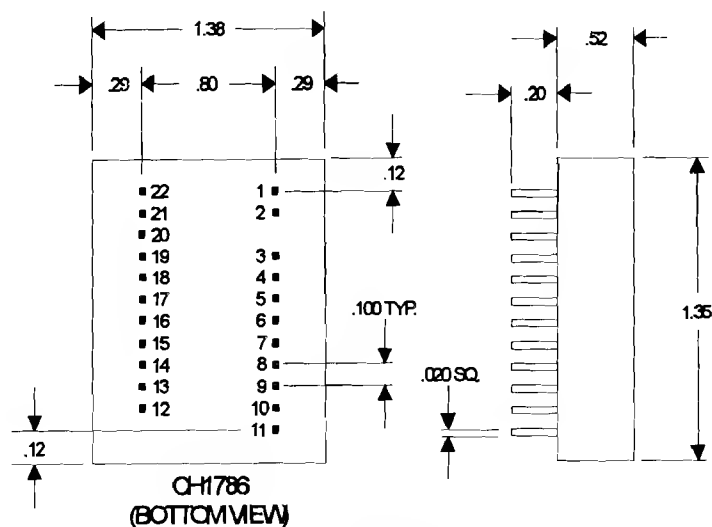
| Parameter                | Description                                      | Min. | Typ.<br>p. | Max. | Units |
|--------------------------|--------------------------------------------------|------|------------|------|-------|
| V <sub>CC</sub>          | Positive Supply Voltage - Noise less than 50mV   | 4.75 | 5.0        | 5.25 | V     |
| I <sub>CC</sub> off Hook | Nominal Operating Current when modem is OFF Hook |      | 50         | 75   | mA    |
| I <sub>CC</sub> on Hook  | Nominal Operating Current when modem is ON Hook  |      | 25         | 50   | mA    |
| I <sub>CCPD</sub>        | Power Down Current                               |      |            | 10   | mA    |
| V <sub>IH</sub>          | High Level Input Voltage                         | 2    |            |      | V     |
| V <sub>IL</sub>          | Low Level Input Voltage                          | -0.3 |            | 0.8  | V     |
| V <sub>T+</sub>          | Positive Hysteresis Threshold for RESET pin      |      | 2.5        |      | V     |
| V <sub>T-</sub>          | Negative Hysteresis Threshold for RESET pin      |      | 1.8        |      | V     |
| V <sub>OH</sub>          | High Level Output (I <sub>OH</sub> =0.5 mA)      | 2.4  |            |      | V     |
| V <sub>OL</sub>          | Low Level Output (I <sub>OL</sub> =1.6 mA)       |      |            | 0.6  | V     |

**Table 6**  
**Other Performance Specifications**

| Parameter                                                      | Min. | Typ.                    | Max. | Units                | Comments                                      |
|----------------------------------------------------------------|------|-------------------------|------|----------------------|-----------------------------------------------|
| Tone 2nd Harmonic Distortion                                   |      |                         | -35  | dB                   | HYB enabled into 60Ω                          |
| DTMF Twist (Balance)                                           |      | 3                       |      | dB                   |                                               |
| DTMF Tone Duration                                             | 50   |                         | 255  | ms                   | 95 ms default                                 |
| Pulse Dialing Rate                                             |      | 10                      | 20   | pps                  | 10 pps default                                |
| Pulse Dialing Make/Break                                       |      | 39/61<br>33/67          |      | %<br>%               | US, Canada default<br>UK, Hong Kong           |
| Pulse Interdigit Interval                                      | 700  |                         | 3000 | ms                   | 789 ms default                                |
| Guard Tone<br>Frequency<br>Amplitude<br>Frequency<br>Amplitude |      | 550<br>-6<br>1800<br>-9 |      | Hz<br>dB<br>Hz<br>dB | referenced to High channel transmit           |
| High Channel Transmit Amplitude                                |      | -1                      |      | dB                   | referenced to Low channel, Guard Tone enabled |
| Guard Tone 2nd Harmonic Distortion                             |      | -40                     |      | dB                   |                                               |
| Call Progress Passband Frequency                               | 120  |                         | 620  | Hz                   |                                               |
| Wait Time for Dial Tone                                        | 2    |                         | 255  | sec                  | Two second default                            |
| Return loss @ 1000 Hz                                          |      | 30                      |      | dB                   | t <sub>r</sub> =600Ω=2.16μF                   |

**Table 7**  
**Temperature Options**

| Model    | Operating Temperature |
|----------|-----------------------|
| CH1786   | 0°C to 70°C           |
| CH1786ET | 0°C to 85°C           |
| CH1786LC | 0°C to 55°C           |



NOTES  
 1. ALL DIMENSIONS ARE IN INCHES  
 2. TOLERANCE =  $\pm .02$  NOMINAL, EXCEPT PINS

| PACKAGE CONNECTION TABLE |          |         |          |
|--------------------------|----------|---------|----------|
| PIN NO.                  | FUNCTION | PIN NO. | FUNCTION |
| 1                        | RING     | 12      | NC       |
| 2                        | TIP      | 13      | OTR      |
| 3                        | RXA      | 14      | DSR      |
| 4                        | TXA      | 15      | RI       |
| 5                        | SPK      | 16      | CTS      |
| 6                        | NC       | 17      | DD       |
| 7                        | NC       | 18      | HS       |
| 8                        | NC       | 19      | VOC      |
| 9                        | NC       | 20      | GND      |
| 10                       | TXD      | 21      | RST      |
| 11                       | RXD      | 22      | RTS      |

Figure 7. CH1786 Physical Dimensions and Pin Functions.

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